3.0   OPTIONS FOR REVISING FACTOR QUALITY ASSESSMENTS

3.1   Introduction

Under Task 3, MACTEC addressed three inadequacies that EPA has identified with the existing AP-42 emissions factor system. These inadequacies are as follows. First, the existing process of developing emissions factors for inclusion in AP-42 is labor intensive, time consuming, and expensive. Second, the existing emissions factor rating system documented in *Procedures for Preparing Emission Factor Documents* is largely subjective in nature and provides limited information regarding the precision, accuracy, and in-source variability of the emissions factors. Third, the emissions factors presented in AP-42 are representative of the arithmetic mean value and do not indicate the range of values that might be applicable for a given factor.

MACTEC has developed options for revising the emissions factor quality assessment process to provide a more objective assessment of emissions factor quality and to provide a more quantitative assessment of the precision, accuracy, and in-source variability of the emissions factors. The following sections document the existing emissions factor development and rating process, the existing emissions factor rating system, and six options for EPA to consider implementing as a means to improve the system.

3.2   Existing Emissions Factor Development and Rating Process

The existing emissions factor development and rating process is documented in *Procedures for Preparing Emission Factor Documents*. Under the current process, five separate tasks are typically conducted to develop and rate an emissions factor. First, test, process, and emissions factor data are identified via literature searches and contacts with EPA, other Federal Agencies, state and local agencies, and industry contacts and trade associations. Second, the desired data are collected. Third, the data are evaluated to determine which data should be used to develop emissions factors. As part of this step, data quality ratings (currently "A" through "D") are assigned to the test data. Fourth, the emissions factor data are grouped into related clusters and average (arithmetic mean) emissions factors are developed. Fifth and finally, the emissions factors are assigned quality ratings that are dependent upon the number of test data points averaged, the test data quality ratings associated with the data points, and the degree to which the test data appear to be representative of the source category as a whole.

The existing emissions factor development and rating process is labor intensive, time consuming, and expensive. For example, based upon data received from Reference 1, the process of revising an existing AP-42 section to incorporate revised emissions factors for only three pollutants would typically require an effort of nearly 150 hours. This estimate was based upon the assumption that 10 test reports would be obtained and analyzed to develop the emissions factors. A task-by-task breakdown of the effort is presented in Table 3.1.

**TABLE 3.1 TYPICAL EFFORT REQUIRED TO UPDATE AN AP-42 SECTION
USING EXISTING PROCEDURES**

Task Description	Required Effort (hr)[a]
Identify data sources	40[b]
Obtain data	10[c]
Analyze data sources and rate test data	90[d]
Group and average emissions factors	3[e]
Rate emissions factors	1[f]
Total	144

[a] Data from Reference 1.
[b] Based upon 4 hours per test report and 10 test reports.
[c] Based upon 1 hour per test report and 10 test reports.
[d] Based upon 3 hours per pollutant per test report, 3 pollutants, and 10 test reports.
[e] Based upon 1 hour per pollutant.
[f] Based upon 1/3 hour per pollutant.

Additional information regarding the existing emissions factor development process was obtained from References 2, 3, and 4. In general, the information provided by these sources agreed with the information presented in Table 3.1. However, these sources also indicated that the time necessary to complete the individual tasks may vary substantially from pollutant to pollutant and from AP-42 section to section. For example, Reference 2 indicated that it may take less than 1 day (8 hours) to identify data sources and obtain data if an AP-42 section is being updated to incorporate industry-provided data or data used to define maximum achievable control technology (MACT). As a second example, Reference 3 indicated that obtaining the data sources for the Oriented Strand Board (OSB) section of AP-42 required 4 days (24 hours) of site visits to State agencies.

Assuming that EPA used contractor support to revise an AP-42 section and an average labor rate of $75/hr, the cost to update the section would be approximately $11,000. It should be noted that this cost estimate neglects the tasks of revising the AP-42 section itself and developing a background information document. MACTEC estimates that accomplishing both of these tasks typically requires an effort of approximately 40 hours (i.e., $3,000). Because many revisions to AP-42 involve updating far greater than three pollutants, Reference 3 indicated that the effort required to revise a section of AP-42 may be as high as $80,000, but typically varies from $30,000 to $50,000. Reference 3 also indicated that the cost to develop a new AP-42 section was considerably higher and might average closer to $100,000.

A second concern associated with the existing emissions factor development process is that an indication of the uncertainty associated with the emissions factors is rarely presented in AP-42. Typically, the emissions factors contained in AP-42 are representative of the arithmetic mean. Although the uncertainty associated with the emissions factors could be calculated (e.g.,

standard deviations or confidence intervals), these data are not typically published in AP-42. [Note: The Background Information Documents associated with Section 2.4 *Landfills* and Section 11.1 *Hot Mix Asphalt Plants* currently include standard deviations for each emissions factor.] As a result, the uncertainty of emissions inventories developed with the emissions factors is not available. Furthermore, there is no means by which to determine where additional effort should be expended to reduce the level of uncertainty in either the emissions factors or emissions inventories developed using these factors. Finally, the existing emissions factors are often used for purposes for which they were not designed (e.g., such as permitting, compliance assessments, and applicability determinations) and for which they might not be scientifically defensible.

3.3   Existing Emissions Factor Rating System

The existing emissions factor quality rating system is documented in Section 4.6.8 of *Procedures for Preparing Emission Factor Documents* and is presented in Table 3.2. Under the existing system, emissions factors are assigned a rating ranging from "A" to "E" depending upon the emissions factor's quality. Emissions factors assigned A ratings are perceived to be of higher quality than B-rated factors and so on, with E-rated factors being of the lowest quality.

Although guidance regarding the assignment of an emissions factor rating is provided in the *Procedures* document, the existing rating system is highly subjective in nature. For example, the *Procedures* document states that an A rating should be assigned if an emissions factor is based primarily (subjective) on A- and B-rated test data (objective, from an emissions factor rating perspective) taken from many (subjective) randomly chosen (somewhat subjective, because while the facilities may have been "randomly" chosen from the available data, the data were only available for facilities that tested their sources) facilities in the industry population. The guidance continues with the statement that an A rating should be assigned if the source category population is "sufficiently specific to minimize variability," which is also subjective in nature. As a result of this inherent subjectivity, the assignment of emissions factor ratings is dependent upon the engineering judgment of the individual developing the rating. Therefore, an emissions factor rated B by one individual might be rated an A, B, or C by someone else.

In real world applications, the number of test data points used to develop an emissions factor appears to have the largest influence on the assignment of an emissions factor rating. However, guidance regarding the number of test data points required to assign a given emissions factor rating varies between EPA Work Assignment Managers (WAMs). For example, Ron Myers directs his contractors to assign an A rating to an emissions factor if it is based upon greater than 20 test data points, a B rating if between 10 and 20 data points were used, a C rating if between 5 and 10 data points were used, a D rating if between 3 and 5 data points were used, and an E rating if less than 3 data points were used [Reference 1]. It should be noted that he typically uses A- and B-rated test data when developing emissions factors and that a preponderance of C- or D-rated data would influence his assignment of an emissions factor rating. On the other hand, Roy Huntley, another EPA WAM, directs his contractors to assign an A rating to an emissions factor if it is based upon greater than 20 test data points, a B rating if between 6 and 20 data points were used, a C rating if between 4 and 5 data points were used, and

a D rating if less than 4 data points were used [Reference 4]. Roy's guidance is to only assign an E rating if it appears that the only test data points available are suspect for one reason or another.

TABLE 3.2 EXISTING EMISSIONS FACTOR RATING SYSTEM

Rating	Guidance
A	**Excellent**. Emissions factor is developed primarily from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category population is sufficiently specific to minimize variability.
B	**Above Average**. Emissions factor is developed primarily from A and B-rated test data from a moderate number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.
C	**Average**. Emissions factor is developed primarily form A-, B, C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.
D	**Below Average**. Emissions factor is developed primary form A-, B-, and C-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source population.
E	**Poor**. Factor is developed for C- and D-rated test data from a very few number of facilities, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population.

The primary problem with the existing emissions factor rating system is that the ratings do not quantify the accuracy or uncertainty associated with each rating. Therefore, although the accuracy is presumably greater for an A-rated emissions factor than for a B-rated factor, the increase in accuracy cannot be quantified based upon the emissions factor rating. Furthermore, the cut points at which an emissions factor would be upgraded from one rating to another are not clearly defined.

Perhaps as a result of the inherent subjectivity of the existing emissions factor rating system and the lack of good statistical data concerning the uncertainty associated with factors given a specific rating, the ratings are largely ignored by the user community. For example, based upon conversations with permit engineers, if an emissions factor is available for a given source category, it will typically be used, regardless of whether it is an A- or E-rated factor.

3.4 Options for Improving the Emissions Factor Development and Rating System

MACTEC has developed five options that EPA may wish to consider to improve the emissions factor development and rating system. In addition, the "no action alternative" was investigated. The advantages and disadvantages of implementation are described for each option.

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3.4.1   Option 1: Do Not Modify Existing System (No Action Alternative)

Under the no action alternative, the existing emissions factor development and rating system would not be modified. It has been assumed that neither the modifications to the test data rating system described under Task 2 of this Work Assignment nor the data automation effort described under Task 4 of this Work Assignment would be implemented under this Option. The advantage of implementing this option is that there would be no effort involved with implementing the option. The disadvantages of implementing this option are that the process of revising an AP-42 section would remain labor intensive, time consuming, and expensive; the emissions factor rating system would remain largely subjective; and the uncertainty associated with emissions factors would remain unquantified.

3.4.2   Option 2: Increase Objectivity of Existing Emissions Factor Rating System

Under Option 2, the existing emissions factor rating system would be modified to increase its objectivity and consistency of application. Specifically, the subjective elements of the existing emissions factor rating system related to the number of test data points and the test data ratings are addressed under this option. This would be accomplished by assigning a numeric value to the test data quality rating associated with each test data point. For example, an A rating could be assigned a value of "4," a B rating a value of "3," a C rating a value of "2," and a D rating a value of "1." A numeric score would be calculated for each emissions factor by multiplying the number of test data points used to develop the emissions factor by the corresponding test data rating value. For example, an emissions factor developed from three data points with test data ratings of A, B, and C would receive a numeric score of 9 [i.e., (1 x 4) + (1 x 3) + (1 x 2)].

Cut points would be established to define the emissions factor rating associated with a given numeric score. For example, the cut points presented in Table 3.3 were defined using Ron Myer's emissions factor rating guidelines and assuming that all of the tests receive an A rating.

TABLE 3.3 PROPOSED EMISSIONS FACTOR RATING SYSTEM

Rating	Numeric Score
A	> 80 (>20 A-rated data points)
B	40-80 (10-20 A-rated data points)
C	20-39 (5-10 A-rated data points)
D	12-19 (3-5 A-rated data points)
E	<12 (<3 A-rated data points)

As with Option 1, it has been assumed that neither the modifications to the test data rating system described under Task 2 of this Work Assignment nor the data automation effort described under Task 4 of this Work Assignment would be implemented under Option 2. The advantages of implementing Option 2 are that the option would require little additional effort to implement, would provide a more objective means of assigning an emissions factor rating, and would standardize the system of assigning emissions factor ratings. The disadvantages of implementing Option 2 are that the process of revising an AP-42 section would remain labor intensive, time consuming, and expensive; and the uncertainty associated with emissions factors would remain unquantified. Furthermore, the assignment of numeric values to both the test data ratings and the cut points would be subjective. Consequently, although the emissions factor ratings would be more objective, they would still remain subjective in nature. Finally, it is unclear that increasing the objectivity of the emissions factor rating system in this manner would have any affect on the user community's apparent disregard for the emissions factor ratings.

3.4.3   Option 3: Screen Rather than Rate Test Data

Under Option 3, the existing emissions factor rating system would be modified to reduce the amount of effort spent during the data analysis and test rating step. Rather than rating the test data using the existing A through D scale, the data would only be screened to ensure that no significant errors were present with the chosen test method. For example, test data developed using the older formaldehyde test method that has been shown to have a significant low bias or the use of Method 25 when concentrations are less than 50 ppm would be eliminated using such a screening methodology. All data that passed the screening test would be included in the emissions factor calculations. Guidance regarding suspect test methods would be provided to assist with the screening analysis.

The advantages of implementing Option 3 are that there would be a significant reduction in the effort required to review test reports and additional test data points (i.e., those that would have been eliminated because they were rated C, D, or E) might be available for inclusion in emissions factor calculations. The disadvantage of implementing Option 3 is that data points that should have been eliminated (e.g., data points for which the appropriate test method was chosen but for which the method was not appropriately implemented) might be included in emissions factor calculations.

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Option 3 could be implemented in conjunction with Option 1 (the no action alternative) or Option 4 (see below). The previously identified advantages and disadvantages would be applicable in either case.

3.4.4   Option 4: Replace Emissions Factor Rating System with Statistical Analyses

Under Option 4, the existing emissions factor system would be eliminated. As previously stated, the existing emissions factor rating system is largely ignored by the user community; therefore; replacing this subjective system with a more quantitative system should not create a significant concern in the user community. In its place, the uncertainty associated with each emissions factor would be quantified and presented in AP-42, along with the arithmetic mean emissions factor.

For statistically valid data sets, the uncertainty could be expressed as a standard deviation, relative standard deviation (i.e., a sample's standard deviation divided by its arithmetic mean), variance, or confidence interval (e.g., 90 percent, 95 percent, or 99 percent). An average measure of uncertainty would be assigned to data sets that are too small for statistical manipulation. For example, based on Reference 5, a relative standard deviation of 1.2 appears to be appropriate for the emissions factors associated with many source categories.

As with Options 1 and 2, it has been assumed that neither the modifications to the test data rating system described under Task 2 of this Work Assignment nor the data automation effort described under Task 5 of this Work Assignment would be implemented under Option 4. Therefore, under this option, the uncertainty calculated for each emissions factor would be an indication of the variability between test data points. It would not be an indication of the uncertainty associated with each specific data point, because these data would not be available.

The advantages to implementing Option 4 are that the option would quantify much of the uncertainty associated with each emissions factor. The disadvantages to implementing Option 4 are that the process of revising an AP-42 section would remain labor intensive, time consuming, and expensive; and the uncertainty associated with each test data point would remain unquantified. Furthermore, the calculation of the uncertainty would require a little more effort than is currently required to calculate just the arithmetic mean value.

3.4.5   Option 5: Implement Option 4 and Automate Data Collection and Test Data Evaluation Procedures

Under Option 5, the statistical analyses described under Option 4 would be implemented and the current rating system would be eliminated. In addition, the modifications to the test data rating system described under Task 2 of this Work Assignment and the data automation effort described under Task 4 of this Work Assignment would be implemented.

The implementation of Task 2 would allow the uncertainty associated with each test data point to be quantified. These data could then be integrated with the inter data point uncertainty

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(previously described under Option 4) to give a complete indication of the uncertainty associated with each emissions factor.

The implementation of Task 4 would allow substantially more data points to be used for the development of emissions factors and for the process to be conducted at a reduced cost. The cost for the initial development of automation technologies proposed in Task 4 would be substantial; however, the development of the emissions factors would benefit from the additional data that could be collected. Once additional data became available through the automation technologies proposed in Task 4, the cost and effort associated with the collection of the test data for each AP-42 section would be reduced substantially and the emissions factor development process would be streamlined.

It should be noted that the use of additional test data points will not necessarily reduce an emissions factor's standard deviation. The reason that the standard deviation may not shrink is that there is often substantial variation in the emissions generated by various sources. Therefore, 10 data points or 100 data points may show the same, rather broad variability. However, the additional data points would improve the accuracy of the arithmetic mean emissions factor value.

The advantages to implementing Option 5 are that the option would reduce the time and effort for data collection and test data analysis and the option would allow the uncertainty associated with each test data point to be quantified in addition to quantifying the variability between sources. The disadvantages to implementing Option 5 are that the up-front cost to implement Tasks 2 and 4 would be substantial and the calculation of the uncertainty would require a little more effort than is currently required to calculate just the arithmetic mean value.

3.4.6   Option 6: Implement Option 5 and Screen Test Data for Use in Emissions Factor Development

Under Option 6, the statistical analyses described under Option 5 would be implemented and the current rating system would be eliminated. In addition, the test data would be screened prior to incorporation into an AP-42 section to eliminate data points with unacceptably large uncertainties. The advantage to implementing Option 6 is that the uncertainty of the resulting emissions factors would be reduced. The disadvantages to implementing Option 6 are that the assignment of a numeric value to the cut point at which data would be eliminated would be subjective and screening the data would require additional effort.

3.5   Presentation of Emissions Factor Data

The option selected under this Task will determine what information is available for presentation in AP-42 and in the Background Information Documents. For Options 1 and 2, the arithmetic mean emissions factor and the existing A through E emissions factor rating would be presented in AP-42. For Options 4 through 6, the arithmetic mean emissions factor and a standard deviation or confidence interval would be presented in AP-42. If desired, additional descriptive statistics such as the median, mode, and variance could be provided either in AP-42 or in the Background Information Documents. For Option 3, the data available for presentation

would be dependent upon whether the option was implemented in conjunction with Option 1 or Option 4.

3.6 Interim Solution

The primary intent of this memorandum is to provide guidance and options for future emissions factor development efforts. However, there are currently over 200 major source categories for which only the arithmetic mean emissions factors and existing A through E emissions factor ratings are presented in AP-42. In the event that Option 4, 5, or 6 is implemented, an interim solution may be desired to provide a measure of the uncertainty associated with the emissions factors defined for each of these source categories prior to the categories' AP-42 sections being fully updated using the new methodology. Reopening the individual AP-42 sections would be time consuming but would also provide users with the information needed to follow the guidance developed under Task 5.

One interim solution would be to use existing data to calculate confidence intervals and standard deviations for all of the current emissions factors that have enough data points to support such analyses. Once the standard deviations and confidence intervals were available, replacing the letter ratings with the statistical values would be rather straight forward. A uniform methodology to address the uncertainty associated with emissions factors that do not have enough data available to complete solid statistical analyses would need to be developed. One option for such a methodology would be to assume that a relative standard deviation of 1.2 is applicable for such data sets.

3.7 References

1. Information regarding the emissions factor development process provided to MACTEC by Mr. Ron Myers, U.S. Environmental Protection Agency, Emissions Monitoring and Analysis Division, May 2004.

2. Information regarding the emissions factor development process provided to MACTEC by Mr. Roy Neulight, Research Triangle Institute, May 2004.

3. Information regarding the emissions factor development process provided to MACTEC by Mr. Dallas Safreit, U.S. Environmental Protection Agency, Emissions Factors and Inventory Group, May 2004.

4. Information regarding the emissions factor development process provided to MACTEC by Mr. Roy Huntley, U.S. Environmental Protection Agency, Emissions Factors and Inventory Group, May 2004.

5. Information regarding the emissions factor uncertainty provided to MACTEC by Mr. Ron Myers, U.S. Environmental Protection Agency, Emissions Monitoring and Analysis Division, May 2004.